

Effects of Experiential Cooperative Concept Mapping Instructional Approach on
Secondary School Students' Motivation in Physics in Nyeri County, Kenya

Patriciah W. Wambugu¹, Johnson M. Changeiywo¹ and Francis G. Ndiritu²

¹Department of Curriculum, Instruction & Educational Management, Egerton University, Kenya

²Department of Physics, Egerton University, Kenya

Abstract

The study of Physics in Secondary Schools is necessary in building up knowledge, basic skills, attitudes and competencies necessary for human resource needs in socio-economic development. Students in Universities and Tertiary colleges should therefore be motivated to enrol in Physics and pursue courses that require Physics. Although learner centred instructional approaches have been encouraged in teaching secondary school Physics, there has been low student enrolment in Physics at Kenya Certificate of Secondary Education (KCSE). This study aimed at finding out the effects of Experiential Cooperative Concept Mapping (ECCM) on students' motivation to learn Physics. Solomon Four Non-equivalent Control Group Design under the quasi- experimental research was used. A stratified random sample of 12 Secondary Schools was drawn from Nyeri County. Four boys' alone schools, four girls' alone schools and four co-educational schools were randomly assigned to four groups with a total of 513 Form Two students. Students in all the groups were taught the same Physics content of Magnetic Effect of Electric Current. The experimental groups were taught using ECCM approach while the control groups were taught through Regular Teaching Methods (RTM). Two groups were pre-tested prior to the implementation of treatment. After five weeks, all four groups were post-tested using the Student Motivation Questionnaire (SMQ). The instrument was validated and pilot tested before use. The reliability coefficient for SMQ was 0.81. The instrument was scored and data

analyzed using t-test, one-way ANOVA and ANCOVA at a significance level of alpha equal to 0.05. The results of the study showed that there was a statistically significant difference between the motivation means of students who were taught through ECCM and those taught through RTM. The researchers recommend the use of ECCM in addressing motivation of students towards learning physics and the current low enrolment in the subject in Kenya.

Key words: Experiential Cooperative Concept Mapping (ECCM), Regular Teaching Methods (RTM), Secondary School students, Physics, Motivation, Nyeri County.

Introduction

Physics is an important subject in the secondary school curriculum because it helps learners apply its principles; acquire knowledge and skills to construct appropriate scientific devices from available resources (Feinstein, 2011; Muni et al., 2006). In addition, it prepares learners for scientific and technological vocations, which play a major role in technological, socio-economic and industrial development in many countries of the world (Waititu et al., 2001). Physics is a key discipline in producing qualified engineers, scientists, teachers and researchers among others. It should therefore be positioned in such a way as to attract many students to pursue it. In many countries, there has been a decline in interest to study Physics and lack of enthusiasm to take it as a course in higher levels in schools. This reduces the number of students wishing to continue with Physics in higher levels (Reid, 2003; Semela, 2010; Soong, 2010). In Kenya, many students shun the subject as compared to Biology and Chemistry. This has led to the low enrolment of the

47

LU JSSEH (2013) VOL. 1: NO.1

subject at the Kenya Certificate of Secondary Examination (KCSE) as compared to that of the other two sciences as shown in Table 1.

Table 1: KCSE Students' Examination Candidature by Subject for Year 2008 to 2010

Year 2008 2009 2010

Total of No of students and

%

305,015 % 337,404 % 357,488 %

No of students in Physics 92,648 30.50 104,188 30.88 109,072 30.51

No of students in Biology 271,735 89.09 299,302 88.71 315,063 88.13

No of students in Chemistry 296,360 97.16 328,922 97.49 347,378 97.17

Source: Kenya National Examinations Council (2009, 2011)

As shown in Table 1, the KCSE examination analysis indicates that the percentage of students opting for Physics is below 30 percent, while those opting for Biology and Chemistry are over 88 percent and 97 percent respectively. A number of reasons have been identified by previous researchers as contributing to this lack of interest. Smithers (2006) noted that the study of Physics in schools and Universities is spiralling into decline as teenagers believe it is too difficult. There is a perception amongst students that the subject is too difficult to grasp conceptually. Williams et al. (2003) observed that the major reason for students finding Physics uninteresting is that it is seen as difficult and irrelevant. Another reason identified is that the teaching method used may not be interesting therefore resulting in more students dropping Physics in upper secondary (Gunasingham, 2009). The concern is how to motivate students and make Physics popular amongst secondary school students, thus reducing this decline in interest. Findings of researchers who focus on teaching various topics in Physics indicate that regular teaching methods hardly improve the teaching of principle concepts in Physics (Crouch & Mazur, 2001; Tanel & Erol, 2008). The foundation for increased interest in Physics takes its root

from the first two years of the secondary school cycle. The Physics curriculum at this level emphasizes the development of lower level cognitive domain; that is knowledge, comprehension and application, before that of the other higher levels, which comprise analysis, synthesis and evaluation (Muni et al., 2006; Wambugu, 2011). This enables the students understand Physics concepts at their early introduction to the subject. The teaching method employed by a teacher has been shown to reflect on students' understanding of the subject. It is also important for teachers to understand and interpret the objectives of Physics. Lack of attention to these aspects of the Physics curriculum by the respective Physics teachers could lead to students' perception of Physics as a difficult, irrelevant and boring subject, thus making them lose interest. It is therefore necessary to use methods which utilize instructional activities whereby students are involved in doing and thinking of the applications of what they are carrying out. Instructional strategies need to be participatory where all the domains of the student are engaged in learning (Muindi, 2008). Adesoji and Ibraheem (2009) are of the opinion that the teaching method adopted by the teacher in order to promote learning is of utmost importance. They therefore concluded that there is need to introduce, adopt and adapt the latest instructional techniques that are capable of sustaining the interest of learners.

The level of cognitive engagement and motivation of students is affected by the teacher controlling almost all activities, assigning a passive role to the students (Hanrahan, 1998). One of

48

LU JSSEH (2013) VOL. 1: NO.1

the most important psychological concepts in education is motivation. Research has shown that motivation is related to various outcomes such as curiosity, persistence, learning and performance (Guay et al., 2008). Motivation plays an important role in determining how much

the students will participate as well as the level of achievement. Self determination theory proposes three categories of motivation; amotivation, extrinsic motivation (which is itself made up of four different types of regulations; external, introjected, identified and integrated) and intrinsic motivation. Each type of motivation varies with regard to the amount of autonomy associated with it and thus lies along a continuum ranging from low (amotivation) to high (intrinsic motivation) self determination (Deci & Ryan, 2008).

Both intrinsic and extrinsic motivation, which could lead to deep involvement in learning, may be constrained by a preponderance of teacher oriented method of instruction. This is because teachers play a significant role in inspiring and motivating students to learn. They are also responsible for creating opportunities that support learners' motivation (Jang, 2008). A teaching approach that a teacher adopts may motivate students to learn. This could consequently improve on the students' interest, perception of relevance of the subject matter and satisfaction during instruction. If students are motivated to learn Physics, not only are they likely to do well in the subject, but they may also opt to take it as an examination subject in KCSE. In addition, they are likely to pursue it later in higher education, and so end up in careers that require physics. There is need for classroom practices that would arouse students' interests and attention, as well as raise their ability to believe that they can accomplish tasks and raise their expectancies of academic work. Classroom tasks, on the one hand, can be structured in such a way that students are forced to compete with one another, work individually or cooperate with one another to obtain rewards that teachers make available for successfully completing these tasks. On the other hand, individualist and competitive classroom practices encourage students to work alone without caring either about others, or students trying to outdo others. These perceptions may cause some students to either avoid challenging subjects or tasks, or give up in the face of difficulty or

reward themselves only if they win a competition and believe that their own successes are due to ability; whereas success of others are due to luck (Ames & Ames, 1984; Dembo, 1994; Dweck, 1986; Hohn, 1995; Spaulding, 1992).

ECCM is a composite instructional approach which combines experiential learning, cooperative learning and concept mapping. The amalgamation of ECCM is such that the elements of experiential learning are combined together with those of concept mapping and cooperative learning. The diversity of learning styles which characterize students' populations makes it necessary for teachers to constantly look for variety in the methods they use (Biggs, 2003). The full involvement of students in the learning process could be achieved through active rather than passive learning approaches. Research findings in Science Education show that active learning has many positive outcomes. It can enhance motivation, increase inquisitiveness, facilitate retention of material, improve classroom performance, and foster development of critical thinking skills. Active learning experienced in ECCM promotes the personal relevance and applicability of course material to students and often improves overall attitudes toward learning (Kalkanis, 2002; Kokatas, 2002; Minas, 2003 & Vlachos, 2004).

In this study, experiential learning is amalgamated with cooperative learning and concept mapping. The integration of the elements of these three instructional approaches would provide a

49

LU JSSEH (2013) VOL. 1: NO.1

teaching strategy which supports contextualization of concepts, which are discussed in interactive groups and therefore provide an appropriate environment for meaningful learning (Keraro, 2008). This may improve students' motivation to learn Physics. The use of ECCM may make students active participants in knowledge construction and facilitate learning of scientific

knowledge as well as assist the students to extend the knowledge by applying it in their everyday lives. In this instructional approach, students participate in the learning process by being provided with opportunities to engage in appropriate concrete experiences as they work in groups. They then draw concept maps and relate the acquired knowledge in their existing knowledge as they apply it to real life situations. The strategy enhances the development of need achievement, self confidence, and self-direction as they present the group concepts maps, through self-determination. The strategy also emphasizes group activity, investigation, social interaction and application of concepts into the real life situations thus making learning interesting (Deci & Ryan, 2008).

A cooperative learning atmosphere, accompanied with prior experiences and application of knowledge to real life situation motivates students out of a sense of obligation, autonomy and self-efficacy (Bandura, 1997; Bandura & Eccles, 2002; Wambugu, 2011, Weinberg et al., 2011). ECCM allows students to know what they are to do, how to proceed through the cycles of learning and how to determine when they have achieved goals. It gives the students an opportunity for the satisfaction of deficiency needs, as they work together in groups towards self actualization. It also allows for learning experiences that give feelings of success and encourages an orientation towards achievement, and strong sense of self-efficacy.

Statement of the Problem

Physics is a fundamental science subject and is also an important base for Science and Technology. The learning of Physics also enhances economic, industrial and technological development. Despite all these, students' enrolment in the subject at KCSE has continued to remain low over the years. Prominent among the factors which have been identified as contributing to the lack of motivation and hence the persistent low enrolment in Physics, are the

instructional strategies adopted by Physics teachers. It would therefore, be necessary to search for effective strategies which may be suitable and efficient for improving motivation to learn Physics to the satisfaction of the current Physics curriculum requirements. The use of instructional approach such as ECCM may help to solve the problem of motivation to learn the subject although this has not been determined in Nyeri County. The study was therefore intended to fill this gap in knowledge, by applying ECCM instructional approach in the teaching of Magnetic Effect of Electric Current in Form Two and establish its effect on students' motivation to learn.

The objective of the study was to compare students' motivation to learn Physics between those taught using ECCM and those taught using Regular Teaching Method (RTM). The null hypothesis as stated below was tested at significance level of alpha (α) equal to 0.05.

Ho1: There is no statistically significant difference in motivation to learn physics between students exposed to ECCM and those that are not exposed to it.

Conceptual Framework

The conceptual framework used in this study was based on constructivist model of learning and the systems approach theory of learning. The knowledge of the learner needs to be probed by exposing them to an instructional approach that will not only allow discussions as in cooperative learning groups, but will give them an opportunity to consciously and explicitly tie the new knowledge to relevant concepts and propositions they already possess (Novak et al., 1983). This study was based on the assumption that an instructional approach that involves students' cooperation and activity, using concept mapping and applying the new knowledge to real life situations may lead to more worthwhile learning than a transmission approach (Hanrahan, 1998). Systems approach to instruction involves setting goals and objectives, analyzing resources,

devising a plan of action and continuous modification. ECCM allowed the learners to go through the four-stage learning cycle in order to effectively learn and apply concepts to real life situations. This was done through doing, reflecting, thinking and planning. Assessment of the content covered was done to ascertain how much the learners learnt. Diagrammatic representation of the framework is shown in Figure 1.

Independent variables Extraneous variables Dependent variables

Figure 1: Conceptual framework for determining the effect of using ECCM instructional approach on students' motivation to learn Physics.

Figure 1 illustrates the conceptual framework that relates the various factors considered to have an effect on students' motivation to learn Physics. The extraneous variables in this study were teacher characteristics, type of school, age and gender of the students. The teacher characteristics were controlled by involving trained teachers who have taught secondary school Physics for a period of at least one year. The age of the students was controlled by involving Form Two students who had comparable age. The type of school and gender of the students were studied by involving the three types of school categories namely boys alone, girls alone and co-educational in the study of students' motivation to learn Physics. The instructional approach used then influenced the students' motivation to learn Physics.

Instructional Approach

- ECCM
- Regular teaching

methods

Learning outcomes

- Students' motivation

to learn physics

(SMQ)

Teacher factors

Training and experience

Learner characteristics

Gender

Age

Classroom environment

Type of school

e.g. Boys only, girls

only, co-educational

51

LU JSSEH (2013) VOL. 1: NO.1

Methodology

Under methodology, the research design, sampling procedure and sample sizes, instrumentation, construction of instructional materials and their use as well as data collection and analysis are discussed.

Research Design

The research design used in this study was quasi-experimental. The researcher used Solomon Four Non-equivalent Control Group Design. This design is particularly strong in quasi-experimental procedure because it ensures the administration of pre-test to two groups and post-test to all the four groups (Gall et al., 1996; Lammers & Badia, 2005; Wachanga & Mwangi, 2004). The design was appropriate because random assignment of the subject was not done due

to the fact that secondary school classes once constituted exist as intact groups and they cannot be reconstituted for research purposes (Trochim, 2006). The research design may be represented as shown in Figure 2.

Group 1 01 X 02

Group 2 03 _ 04

Group 3 _ X 05

Group 4 _ _ 06

Figure 2: The research design used in the study

In figure 2, 01 and 03 were pre-tests, whereas 02, 04, 05 and 06 were post-tests. X represents the experimental treatment, where students were taught using Experiential Cooperative Concept Mapping approach (ECCM). The broken lines indicate that the experimental and control groups were not formed randomly. The groups are explained as follows:

(i) Group 1 was the experimental group which received a pre-test, the treatment condition X and the post-test;

(ii) Group 2 was the control group, which received a pre-test followed by the control condition and a post-test;

iv) Group 3 was the experimental group which received the treatment X and a post-test but did not receive the pre-test; and

v) Group 4 was control group which received the post-test only.

Group 2 and 4 were the control groups who were taught using regular teaching method while

Group 1 and 3, the experimental groups were taught using ECCM.

Sampling Procedure and Sample Size

The sampling unit was the secondary school and not individual students since schools operate as intact groups. The sampling technique that was used in the study was stratified sampling procedure (Sanders & Pinhey, 1979; Trochim, 2006). The various types of schools were considered as groups (strata). The independent samples were selected from within each of the stratum using simple random sampling. This enabled the researchers to have three strata, namely; boys alone, girls alone and co-educational. There were eight boys' only, nine girls' only, and thirty co-educational schools that were selected. Four schools from each category were randomly selected. The four schools in each category were randomly assigned to the experimental and control schools such that each group in the experiment had three schools; one boys' only, one girls' only and one co-educational school. A summary of the school type and number of students is shown in Table 2.

Table 2: Summary of School Type and Number of Students Involved in the Study

| School | Female | Male | Total |
|--------|--------|------|-------|
|--------|--------|------|-------|

| | | | |
|------------|-----|-----|--|
| Boys' only | 176 | 176 | |
|------------|-----|-----|--|

| | | | |
|-------------|-----|-----|--|
| Girls' only | 168 | 168 | |
|-------------|-----|-----|--|

| | | | |
|----------------|----|----|-----|
| Co-educational | 79 | 90 | 169 |
|----------------|----|----|-----|

| | | | |
|-------|-----|-----|-----|
| Total | 247 | 266 | 513 |
|-------|-----|-----|-----|

A total of 513 form two students were assigned to the four groups as follows;

Group 1 (Experimental group) N= 125

Group 2 (Control group) N= 130

Group 3 (Experimental Group) N= 129

Group 4 (Control group) N= 129

Total N= 513

All the form two students were exposed to the same content of magnetic effect of electric current.

Instrumentation

The instrument used was composed of a Students Motivation Questionnaire (SMQ). The instrument was developed and validated before the commencement of the study. SMQ was constructed using Keller's ARCS motivation theory (Hohn, 1995). The researchers developed the SMQ and were guided by the ones used by Kiboss (1997), Wachanga (2002) and Bunting et al. (2006). SMQ contained 60 five point Likert-scale items on favourable and unfavourable statements of the students' motivation towards ECCM versus Regular Teaching Methods. SMQ was pilot tested in schools where the respondents who were not involved in the research study had similar characteristics with those of the respondents in the study. Cronbach's coefficient alpha method was used to estimate the reliability of the questionnaire. The alpha value was 0.806 which rounds off to $\alpha = 0.81$. This value of reliability coefficient was acceptable for the study according to Fraenkel and Wallen (2000).

Construction of Instructional Materials and their Use

The instructional materials used in the study were based on the Kenya Institute of Education syllabus (KIE, 2002). The Physics topic of Magnetic Effect of Electric Current, which is normally covered in form two, was chosen for the study. The topic has been reported to be difficult by the Kenya National Examination Council in their analysis of the KSCE results (KNEC, 2009; 2011) and yet it is a foundational topic that combines the effects of magnetism and electricity. The instructional materials included a training manual on ECCM for teachers and

a teachers' guide to implementing ECCM on magnetic effect of electric current. The manuals were used throughout the treatment period.

The teachers in the experimental groups were trained by the researchers on skills of ECCM for one week. Due to ethical reasons, all the physics teachers in the experimental groups were

53

LU JSSEH (2013) VOL. 1: NO.1

trained on the use of ECCM instructional approach even if they were not teaching form two classes. After the training, the students were taught using ECCM on a different topic other than Magnetic Effect of electric Current. This was to enable them master the skills. The treatment started and the experimental groups were taught using ECCM while the control groups were taught using RTM on the topic of Magnetic effect of Electric current. The lessons for the experimental groups were planned in such a way that the learning process involved the four cycles of experiential learning and students held discussions in their various groups. The students also discussed and drew concept maps that were later presented on the chalk board for further discussions. The control groups were taught through the regular teaching methods for the same period. At the same time, all form two students in the schools involved in the study were taught using a similar method.

Data Collection and Analysis

Pre-tests were administered to groups 1 and group 2 before the treatment condition. After five weeks of treatment condition, a post-test was administered to all groups. The researchers then scored SMQ and generated quantitative data, which was analyzed. Data was analyzed using t-test, One-way ANOVA and ANCOVA. The Least Significant Difference (LSD) Post Hoc test was done to establish where the difference in mean scores existed. ANCOVA was used to cater

statistically for initial differences among the groups. ANCOVA is a superior method that is used to compensate for lack of equivalence (Ary et al., 1979). All tests of significance were performed at a significant level of alpha equal to 0.05.

Results and Discussion

The Solomon four-group design used in this study enabled the researchers to have two groups sit for pre-tests as recommended by Gall et al. (1996). This enabled the researchers to assess the effects of the pre-test relative to no pre-test and assess if there was an interaction between the pre-test and the treatment conditions. The results of the t-test are shown in Table 3.

Table 3: Independent Samples t-test of the Pre-test Score on SMQ

Scores on SMQ Group 1, N= 125 Group 2, N= 130

Variable Group Mean sd df t-value P- value

SMQ 1 197.49 15.16 253 0.038 0.97(ns)

2 197.40 20.83 0.038

sd =Standard; df = 253; t-critical = 1.96; P < 0.05

The results of table 3 reveal that the mean scores of groups 1 and 2 on SMQ are not statistically significantly different since $t(253) = 0.038$, $P > 0.05$. This means that groups used in the study for SMQ exhibited comparable characteristics. The groups were therefore suitable for the research study.

Effects of ECCM on Students' Motivation to Learn Physics

The Hypothesis HO1 of the study sought to examine the effect of ECCM on students' motivation to learn Physics. This hypothesis indicated that there was no statistically significant difference between students exposed to ECCM and those that were not. The post-test SMQ scores were analyzed. Table 4 shows the results of the mean scores for the four groups on the SMQ post-test.

Table 4: Mean Scores for Post-test on SMQ

| Group | N | Mean | sd |
|-------|-----|--------|-------|
| 1 | 125 | 225.18 | 14.83 |
| 2 | 130 | 194.96 | 22.21 |
| 3 | 129 | 224.43 | 15.47 |
| 4 | 129 | 195.71 | 24.45 |

sd= Standard Deviation

In order to establish whether the differences between the groups were statistically significant, analysis of variance was done. The results are shown in Table 5.

Table 5: Analysis of Variance (ANOVA) of the Post-test SMQ Scores

| | Sum of squares | df | Mean Square | F | P- Value |
|----------------|----------------|-----|-------------|------|----------|
| Between Groups | 111934.52 | 3 | 37131.51 | 95.4 | 0.00 |
| Within Groups | 198105.51 | 509 | 389.21 | | |
| Total | 309500.04 | 512 | | | |

df=(3,509; F-critical = 2.70; P<0.05

The results show that there was a statistically significant difference within the four groups. Post-Hoc multiple comparisons were thereafter done to establish where the differences were. The results indicated that the pairs of SMQ mean scores for Groups 1 and 2, Groups 1 and 4 and Groups 2 and 3 with an alpha level of 0.05 were statistically significant different. However, there was no statistically significant difference at alpha level of 0.05 in the mean scores of Groups 1 and 3, and 2 and 4. Since the study involved quasi-experimental design, it was necessary to carry

out analysis of covariance. The analysis was carried out by performing the analysis of covariance on the SMQ post-test with KCPE scores as the covariate. The results of the adjusted mean scores for SMQ are shown in Table 6.

Table 6: Adjusted SMQ Post-test Mean Scores in the ANCOVA

| Group | N | Mean | Std. Error |
|-------|-----|--------|------------|
| 1 | 125 | 224.29 | 1.77 |
| 2 | 130 | 196.02 | 1.75 |
| 3 | 129 | 223.62 | 1.74 |
| 4 | 129 | 196.31 | 1.73 |

The data in Table 6 shows that the mean score for the experimental group is higher than the control group for post test SMQ means scores after adjustments. With the adjusted means, the researchers did the analysis of covariance of the post-test. Results of this analysis are shown in Table 7.

55

LU JSSEH (2013) VOL. 1: NO.1

Table 7: Analysis of Covariance of the Post-test Scores on the SMQ

| | Sum of squares | df | Mean Square | F | P- Value |
|-------|----------------|-----|-------------|-------|----------|
| Group | 90459.29 | 3 | 30153.1 | 78.84 | 0.00 |
| KCPE | 3827.23 | 1 | 3827.23 | 10.00 | 0 |
| Error | 194278.28 | 508 | 382.44 | | |

df=(3,508); F-critical = 2.72; P<0..05

The results indicate that there was a statistically significant difference between the groups F (3,508) = 78.84, P< 0.05. To establish where the differences were, a Post Hoc pair-wise

comparison was carried out. The results indicated that the results of ANCOVA were statistically significantly different at alpha level of 0.05 between Groups 1 and 2, between Groups 1 and 4, Groups 2 and 3, and Groups 3 and 4. However, there are no statistically significant differences at alpha level of 0.05 between Groups 1 and 3, and Groups 2 and 4. These results agreed with those of ANOVA; they indicated that the experimental groups had higher motivation to learn than the control groups. This therefore means that ECCM instructional approach had an effect on students' motivation to learn Physics. The results of the analysis of variance and those of analysis of covariance for SMQ post-test mean scores indicate that ECCM had an effect on students' motivation to learn Physics. Hypothesis HO1 is therefore rejected. This means that ECCM instructional approach motivated students to learn Physics as compared to RTM.

The results of this study indicate that ECCM instructional approach increases motivation towards learning Physics. This is probably due to the fact that when students work in groups, and as they draw the concept maps and apply the experiences to real life situation, they feel that they can depend on each other for help and that the concept learnt could also have meaning to their daily lives. This increases their confidence in performing tasks and solving problems in Physics.

ECCM actively involves students in the learning process. These findings are consistent with the findings of previous researchers such as Ifamuyiwa and Akinsola (2008), Anderson 2006; Keraro et al. (2007); Kelly and Kolb (2002) and Berger and Hanze (2007).

ECCM instructional approach provides a balanced approach to instruction that serves as a motivating force for many students to engage in the learning process. Unlike the regular teaching method, this approach resulted in higher students' motivation. The regular methods of teaching assume that the teacher is the person in authority in the classroom whose job is to impart knowledge and skills to the learners. Students tend to see their role as relatively passive

recipients of the knowledge and they expect the teacher to be in charge of their learning. Students learn but the cooperation amongst them is limited by competition for grades. In contrast, ECCM provides intrinsic motivation and self directed learning. Learners see themselves as increasingly competent and self determined and assume responsibility for their own learning. This is provided by the elements of each of the instructional approach contained in ECCM. Experiential learning offers students opportunities to learn in real life application. The four stages that are involved in the learning process concretise experience, which provides learning by intuition with emphasis on personal experiences. The activities that support this approach include group discussions which cooperative learning caters for. Reflective observation, where learning is done by perception, focuses on understanding ideas, concepts and situations by careful

56

LU JSSEH (2013) VOL. 1: NO.1

observations. This is also achieved through construction of concept maps which are done in cooperative groups. This increases students' satisfaction and motivation to learn.

Abstract conceptualization is where learning requires rigorous thinking using a systematic approach to structure and frame phenomena. Concept mapping allows accomplishment of this stage since it emphasizes on linking concepts and ideas with words in the maps. The fourth stage; active experimentation is where learning is attained through action. This involves learning through transfer of learning and application to the real world. This consequently led to increased motivation when ECCM was used as compared to use of regular teaching methods. These results concur with those of Clinton and Kohlmayer (2005) in their study on the effects of group quizzes on performance and motivation to learn. These findings also agree with those of Gahr (2003) who found out that the students in a cooperative chemistry concept mapping class were

motivated to learn and hence performed well.

ECCM employ a variety of motivational techniques to make instruction more relevant and students more responsible. This kind of instruction strategy encourages students to see their ability in performing the task to completion, hence increasing their self-efficacy which leads to increased motivation to learn. Also, when students work in groups, they can role model each other; a student is able to observe others doing an activity and therefore gets encouraged to do equally well. The role played by the teacher is that of a facilitator, hence the teacher has minimal control over the working of groups. This encourages autonomous group work and increases self determination. According to Deci and Ryan (1985), the level of intrinsic motivation increases when students act by self determination. Forsyth and McMillan (1994) emphasize intrinsic motivation as a key element in teaching and learning. They note that successful intrinsic motivation develops attitude, establishes inclusion, engenders competence and enhances meaning within diverse students. ECCM is therefore an instructional approach that can enhance intrinsic motivation, as proved by the results of this study.

The primary benefit of cooperative learning in ECCM is that it enhances students' self esteem and satisfaction with the learning experience by actively involving students in designing and completing class procedures and course content (Johnson & Johnson, 1998). Experiential learning motivates students to learn in that it stresses the full involvement of students in the learning process. This is achieved through active learning as opposed to passive learning as it is reflected in findings of Mckeachie (2001). Findings of research studies in Physics education also point out that active learning has many positive outcomes such as enhancing motivation, improving classroom performance and development of critical thinking (Kalkanis, 2002). The results of this study concur with the findings of these researchers, since ECCM enabled the

students not only to be actively involved but also encouraged groups working together throughout the learning process.

Concept mapping as an instructional strategy, combined with cooperative learning motivates students to learn. This is because concept mapping as a learning strategy stimulates learners' commitment and involvement in negotiation of ideas, which is very important if learning is to take place meaningfully (Cansas et al., 2004). This study therefore found out that if each of the instructional approaches in ECCM has the potential of motivating students to learn, then when integrated in an organized way, they may help students to perceive the relevance of Physics to

57

LU JSSEH (2013) VOL. 1: NO.1

their lives as well as be highly motivated to learn. This concurs with the finding of Kolb and Kolb (2005); Kayes, et al. (2005); Fuifong and Hong Kwen (2007) and also those of Berger and Hanze (2007). Their findings indicate that students through experiential learning, cooperative learning and concept mapping are more engaged in the learning process, achieve better understanding of Physics concepts and their motivation to learn increases. It can therefore be concluded that ECCM provides many advantages to teachers and learners in relation to the teaching and learning of Secondary School Physics, since it incorporates all the elements of the three strategies. The ECCM instructional approach also resulted in better student-student, student-teacher interactions; helped students to understand, integrate and clarify Physics concepts; and also enabled students have a critical link between classrooms and the real world. This improves students' motivation as was shown by the results of SMQ in this study.

This study has also shown that the instructional approach resulted in an improvement in the four conditions which exist in a motivated learner. These conditions are Attention, Relevance,

Confidence and Satisfaction (Hohn, 1995). Students' attention improved as they drew concept maps in cooperative groups and in their discussions on the application of learnt concepts on magnetic field due to current and electromagnets to real life situations. The goals of each group were set with the involvement of the students in advance. This made the members feel that the course content was valuable to them. Through application to real life situations, learners appreciated the fact that the skills and knowledge acquired will have future usefulness.

Encouragement from fellow group members increased the students' confidence. This was also enhanced by the feedback which came from the presentation of the concept maps and applications of learnt knowledge by various groups (Appendix A).

Satisfaction of the students was as a result of the achievement of goals and the students' feeling that the skills and knowledge were useful. They also felt less patronized by their teacher. The higher motivation acquired by students who were taught through ECCM instructional approach strengthens the case for the implementation of this method in teaching secondary school Physics.

Motivated students will want to continue with the task even when it is difficult. An important note of the instructional strategy used in this study is that of intrinsic motivation and self-directed learning. The learners, as they go through the learning cycle, in their respective groups are able to see themselves as competent and capable as they assume responsibility for their learning.

Conclusion and Implications

Based on the findings of this study, it can be concluded that students who learnt Physics under ECCM instructional approach have higher motivation to learn than the students who learnt through regular teaching methods.

The findings of the study provide evidence that ECCM instructional approach improves motivation to learn Physics in secondary schools. The increased motivation to learn physics

would lead to a better representation in scientific occupation, even as Kenya looks forward into achieving Vision 2030. The superiority of ECCM instructional approach over the regular teaching method could be attributed to the fact that it is an integration of three teaching approaches. Its strength is therefore in the elements of cooperative learning that make students develop more positive attitude toward the self and learning in general. On concept mapping, students are engaged in knowledge construction as they find new ways to link concepts, while in

58

LU JSSEH (2013) VOL. 1: NO.1

experiential learning, students learn through experience as they conceptualize what they learn and apply it to real life situations. ECCM instructional approach by its nature, promotes self efficacy and self determination, which in turn fosters intrinsic motivation to perform tasks in Physics. This type of instructional approach moves beyond rote memorization and goes to the level of understanding, linking and integration of concepts. The Ministry of Education in its effort to make teaching more effective should therefore encourage Physics teachers to use this method.

Recommendations and Areas for Further Research

Pedagogical competence of Physics teachers stands as a major challenge. The teachers need skills to concretize theoretical and practical notion of Physics in a manner that links acquired knowledge, skills and attitude to students' everyday life situations. Based on the findings of the study, the following recommendations have therefore been made;

(i) Teacher education programmes should be focused towards preparing Physics teachers to acquire appropriate skills in instructional strategies such as the ECCM instructional approach which could promote effective teaching-learning process. ECCM instructional

approach should be included in the methods courses in training of Physics teachers at University and Teacher training Colleges. The teacher preparation course must emphasize the importance of using all components of ECCM instructional approach for positive student learning.

(ii) Textbook writers should shift emphasis from teacher activities to students' activities as well as incorporating principles of ECCM instructional approach in new Physics text books to be produced.

The findings of the study indicate that ECCM instructional approach is effective in improving Physics instruction thus motivating students. However, there are areas that warrant further investigation. These include the following;

(i) How ECCM instructional approach would lead to a significant increase in the choices related careers by students, especially girls.

(ii) How to improve psycho-motor objectives through ECCM. This would improve on the acquisition of science processing skills.

References

Adesoji, F. A., & Ibraheem, T. L. (2009) Effects of Students Teams- Achievement Divisions strategy and Mathematics Knowledge on Learning Outcomes in Chemical Kinematics.

Journal of International Social Research. 2(6).15-25

Ames, R., & Ames, C. (1984) Research on Motivation in Education. Orlando, FL Academic.

Anderson, J.R. (2006) Cooperative and Competitive Learning in the Management Classroom Mountain. Plain Journal of Business and Economics. Pedagogy 17 1-10

Ary, D., Jacobs, L.C., & Razavieh, (1979) Introduction to Research in Education (2nd ed.)N.Y: Holt, Rinehart and Winston Inc.

Bandura, A. (1997) *Self-Efficacy: The Exercise of Control*. New York: W.H. Freeman.

Bandura, A., & Eccles, J.S. (Eds.) (2002) *Development of Achievement Motivation*. San Diego: CA. Academic Press.

Berger, R., & Hazne, M. (2007) *The Jigsaw Method in the Upper Secondary Physics- Its Impact on Motivation, Learning and Achievement*. Paper presented at ESERA. Barcelona: Spain.

59

LU JSSEH (2013) VOL. 1: NO.1

Biggs, J. (2003) *Teaching for Quality Learning at University*. (2nd Ed). Maidenhead Bershire: Open University Press.

Bunting, C., Coll, R. K., & Campbell, A. (2006) *Students Views of Concepts Mapping Use in Introductory Tertiary Biology Classes*. *International Journal of Science and Mathematics Education*. 4, 641-668.

Clinton, D., & Kohlmeyer, J.M. (2005) *The Effects of Groups Quizzes on Performance and Motivation to Learn. Two Experiments in Cooperative Learning*. *Journal of Accounting Education*. 23 (2), 96-116.

Crouch, C.H., & Mazur, E. (2001) *Peer Instruction: Ten Years of Experience and Results*. *American Journal of Physics*. 69, 970-977.

Deci, E.L., & Ryan, R.M. (2008) *Facilitating, Optimal Motivation and Psychological Well Being Across Life Domains*, *Canadian Psychology*. 49, 14-23.

Deci, E.L., & Ryan, R.M. (1985) *Intrinsic Motivation and Self-Determination in Human Behaviour*. New York, NY: Plenum.

Dembo, M.H. (1994) *Applying Education Psychology* (5th ed.). NY: Longman White Plains.

Dweck, C.S. (1986) *Motivational Processes Affecting Learning*, *American Psychologist*. 41 (10),

1040-1048.

Feinstein, N. (2011) Salvaging Science Literacy. *Science Education*, 95, 168 – 185.

Forsyth, D.R., & Mcmillan, J.H. (1994) Practical Proposals for Motivating Students. In R.J.

Menges & M.D Svinick (eds) (1991) *College Teaching from Theory to Practice: New*

Directions for Teaching and Learning. San Francisco.

Fraenkel, J.R., & Wallen, N.E. (2000) *How to Design and Evaluate Research in Education*. 5th

ed. McGraw Hill Companies Inc.

Fuifong, H. & Hong Kwen, B. (2007) Cooperative Learning Exploring its Effectiveness in the

Physics Classroom. *Asian- Pacific Forum of Science Learning and Teaching*.

Gahr, A. A. (2003) Cooperative Chemistry Concept Mapping in the Organic Chemistry Lab

(Electronic Version). *Journal of College Science Teaching*. 32, 311-315.

Gall, M.D., Borg, W. R., & Gall, J. P. (1996) *Educational Research: An Introduction*. White

Plains NY: Longman.

Guay F., Ratelle, C.F., & Chanal, J. (2008) Optimal Learning in Optimal Contexts: The Role of

Self-determination in Education. *Canadian Psychology*. 49, 233-240.

Gunasingham (2009) Why Singapore needs more People to Study Physics. *Strait Times Science*

PDIO. National University of Singapore.

Hanrahan, M. (1998) The Effects of Learning Environment Factors on Students Motivation and

Learning, *International Journal of Education*, 20 (6), 737-753.

Hohn, L.R. (1995) *Classroom Learning and Teaching*. New York: Longman Publishers Ltd.

Ifamuyiwa, S.A., & Akinsola, M.K. (2008) Improving Senior Secondary School Students

Attitude Towards Mathematics Through Self and Cooperative Instructional Strategies.

International Journal Mathematics Education. Science and Technology. 39, 569-585.

Jang, H. (2008) Supporting Students' Motivation, Engagement, and Learning During and Uninteresting Activity. *Journal of Education Psychology* 100 (4), (798-811).

Johnson, D. W., & Johnson, R. T. (1998) Learning together and alone; Cooperative Competitive, and Individualistic learning (5th ed.) Needham Heights, MA; Allyn & Bacon

Kalkanis, G.T. (2002) Educational Physics. From Microcosm to Macrocosm: Athens: Grigoris.

Kayes, A. B., Kayes, D. C., & Kolb D. A. (2005) Experiential Learning in Teams. *Simulations and Gaming*. 36 (3), 330-354.

60

LU JSSEH (2013) VOL. 1: NO.1

Kelly, C., & Kolb, D. (2002) The Theory of Experiential Learning and ESL

<http://www.aitech.ac.jp/~iteslj/articles/Kelly-experiential>.

Kenya Institute of Education (KIE) (2002) Secondary Education Syllabus. Volume Seven. Self

Kenya National Examination Council (KNEC) (2009) The Year 2008 Kenya Certificate of Secondary Education (KCSE) Examination Report Self.

Kenya National Examination Council (KNEC) (2011) The Year 2010 Kenya Certificate of Secondary Education (KCSE) Examination Report Self.

Keraro, F.N. (2008) Personal Verification: The Risk of Education. *Education and Reality*.

Reflections of Luigi Giussanis. (Eds Sanna, P. Otiende, J. E., Aseka E.M., Mburu J.N., M.

Kiio & Koech J.). *Fondazionle Ausi & Kenyatta University - Nairobi, Kenya*.

Keraro, F.N., Wachanga, S.W., & Orora, W. (2007) Effects of Cooperative Concept Mapping Teaching Approach on Secondary School Students' Motivation in Biology in Gucha

District, Kenya. *International Journal of Science and Mathematics Education*. 5, 111-124.

Kiboss, J. K., (1997) Relative Effects of a Computer-based Instrument in Physics on Students

Attitudes, Motivation and Understanding about Measurement and Perceptions of Classroom Environment. Unpublished PhD Thesis, University of Western Cape: Bellville.

Kokatas, P. (2002) Didactics of Physical Sciences II. Athens, Grigoris.

Kolb, D.A., & Kolb, A.Y. (2005) Learning Styles and Learning Spaces. Enhancing Experiential Learning in Higher Education. *Academy of Management Learning & Education*, 4 (2), 193-212.

Lammers, J., & P. (2005) *Fundamentals of Behavioural Research* (1st Ed.) Newberry Award Records: Inc NY.

Mckeachie, W.J. (2001) Active Learning. <http://hydro4.sc.fau.edu/~rjordan/activelearning.htm>.

Minas, P. (2003). *Teaching Physics in Primary Education*. Athens: Ellinika Grammata.

Muindi, B. (2008) New Strategy to Improve Science Performance in Kenyan Schools. *Daily Nation* (July) Nairobi, Kenya: Nation Media Group Ltd.

Muni E.K., Miano P. M., Njeremani, D., Waweru, C. K., Muriithi W., Kazungu, J. C., Wambugu, P., Makunda, C., Olukutukei, B., & Kiriani, H. G. (2006) Ministry of Education. *Secondary Physics Teachers Handbook*. Kenya Institute of Education (K.I.E).

Novak, J. D., Gowin, B., & Johansen, G.J. (1983) The Use of Concept Mapping and Knowledge Mapping with Junior High School Science Students. *Science Education*. 67 (5), 625-645.

Reid, N. (2003) Gender and Physics. *International Journal of Science Education*, 25 (4). 509-536.

Sanders, W.B., & Pinhey, T.K. (1979) *The Conductor of Social Research*: Holt Rinehart and Winston Inc Orlando.

Semela, T. (2010) Who is Joining Physics and Why? Factors Influencing the Choice of Physics among Ethiopian University Students. *International Journal of Environmental and*

Science Education, 5 (3), 319-340.

Soong, B. (2010) Improving Secondary Students Revision of Physics Concepts through Computer – Mediated Peer Discussion and Prescriptive Tutoring. Unpublished PhD Dissertation, University of Cambridge.

Smithers, R. (2006) Physics in Downward Spiral as Pupils Think it is too Difficult, UK: the Guardian

Spaulding, C.L. (1992) Motivation in the Classroom. New York: Mc Graw – Hill, Inc.
61

LU JSSEH (2013) VOL. 1: NO.1

Tanel, Z. & Erol, M. (2008) Effects of Cooperative Learning on Instructing Magnetism. Analysis of an Experimental Teaching Sequence Lat. AM. J. Phy. Edu. 2 (2), 124 or <http://www.journal.lapen.org.mx>.

Trochim, W.M.K. (2006) Research Method Knowledge Base (2nd ed). Atomic Dog Publishing Cincimatic Off.

Vlachos, I. A. (2004) Educating in the Physical Sciences: The Constructivist Approach. Athen: Grigoris.

Wachanga, S. W. (2002) Effects of Cooperative Class Experiment Teaching Method on Secondary School Students' Motivation and Achievement in Chemistry. Unpublished PhD Thesis. Egerton University.

Wachanga, S. W. & Mwangi, J. G. (2004) Effects of Cooperative Class Experiment Teaching Method on Secondary School Students' Chemistry Achievement in Kenya's Nakuru District. International Education.5 (1), 26-36.

Waititu, M., Takemura, Chesire, B., Rutto, P., Gitau, G., & Mutua M. (2001) Towards Better

Teaching and Learning of Physics. SMASSE Project INSET Unit Physics Department.

Williams, C., Strainstreet, M., Spall, K., Boyes, E., & Dickson, D. (2003) Why Aren't Secondary Students Interested in Physics? *Physics Education*, 38 (4), 324-329.

Wambugu, P. W. (2011) Effects of Experiential Cooperative Concept Mapping Instructional Approach on Secondary School Students' Achievement and Motivation in Physics in Nyeri County, Kenya. Unpublished PhD Thesis, Egerton University, Kenya.

Weinberg A., E, Basile C.G., & Albright L., (2011) The Effect of an Experiential Learning Programme on Middle School Students' Motivation towards Mathematics and Sciences.

RMLE. Research in Middle Level Education 35 (3), 1-12.

Appendix A

A Sample of students' modified concept maps